

of the climatic features of British Columbia, may be found in an appendix written by me for the Canadian Pacific Railway Report of 1880, p. 107.

The mean temperature of Tongass at the southern extremity of Alaska, from two years' observations, is stated as $46^{\circ}5$.

Observations have been maintained at Sitka with little interruption for a period of forty-five years. The latitude of this place is $57^{\circ}3'$, or about one degree north of Glasgow. The mean temperatures are as follows:—spring $41^{\circ}2$, summer $54^{\circ}6$, autumn $44^{\circ}9$, winter $32^{\circ}5$, and for the year $43^{\circ}3$.

According to the *Pacific Pilot* above quoted, that portion of the Kuro-siwo, having a temperature of 55° F. or more, approaches the coast in the vicinity of Vancouver Island. Temperatures not much lower than this however prevail much further north. The average temperature of the surface of the sea during the summer months in the vicinity of the Queen Charlotte Islands as determined by me in 1878 ("Report of Progress, Geological Survey of Canada, 1878-79") is $53^{\circ}8$. Observations by the U.S. Coast Survey in 1867, in the latter part of July and early in August between Victoria and Sitka, gave a mean surface-temperature of $52^{\circ}1$.

GEORGE M. DAWSON

Geological Survey of Canada, February 1

"The New Cure for Smoke"

It was not my intention to trouble you further on this subject at present, but as Dr. Siemens has been good enough to notice the result of my trials with the coke-gas grate, and has asked a question with reference to the grate used by me, it is due to that gentleman that I should at once explain that the grate in which the trials were made is of modern construction and permanently fitted with side-cheeks and back of fire-clay lumps, and that when in use with the coke and gas the back was fitted with a copper plate, and in all other respects the grate was arranged in the manner described and illustrated in *NATURE*, vol. xxiii. p. 26.

J. A. C. HAY

On the Space Protected by Lightning-Conductors

THE very interesting article by Mr. W. H. Preece on the "Space Protected by a Lightning-Conductor" (*Phil. Mag.* 5th series, vol. x. p. 427 *et seq.*, December, 1880) revives this important practical question. The old rule, first enunciated by M. Charles, which makes the radius of the protected circular area around the base of the rod equal to twice its vertical height, has never been satisfactorily verified either on theoretical or experimental grounds. This rule was adopted in the Report of the Commission of the French Academy of Sciences drawn up by M. Gay-Lussac in 1823 (*Ann. de Chim. et de Phys.* 2nd series, t. 26, p. 258), and also in two other reports drawn up by M. Pouillet, one in 1854 (*Comptes rendus*, t. 39, p. 1142), and the other in 1867 (*Comptes rendus*, t. 64, p. 102). But still more recently the Committee appointed by the Préfet de la Seine to superintend the construction of lightning-conductors in the City of Paris, in their Report in February, 1876, reduced the radius of the protected area to $1\frac{1}{4}$ times the height of the rod. I am ignorant on what grounds the Commission adopted this precise number.

In this state of the problem Mr. Preece's paper was both apposite and welcome. The rule which he deduces certainly has the merit of definiteness; but it seems to me that it fails to be practically satisfactory. For it is very evident that his investigation is exclusively applicable to "*Blunt-Conductors*," since the "*Power of Points*" is entirely left out of consideration. His deductions might apply to the *blunt*-conductors which crowned the Royal Palace of George III., but are scarcely applicable to the *pointed* rods now employed! His investigation assumes that the distance of the earth-connected objects from the electrified cloud is the *only* element which determines the *direction* of the discharge. It seems to me that the well-established "*power of points*" to discharge, or rather to *neutralise* the electricity of charged conductors, is an essential element in the problem of the protected space.

It is a well-known fact that when an electrified cloud approaches a *pointed* lightning-conductor which is in good conducting connection with the earth, the sharp point becomes charged by induction with opposite electricity of *high tension* long before the distance between them approximates that required for a *disruptive* discharge; so that electricity of the opposite kind from that of the cloud *escapes* from the point in the form of a *connective discharge* or electrical glow, and

neutralises that of the cloud, and thus silently *disarming* it, averts the disruptive stroke of lightning. This *neutralisation*, due to the power of points, constituting the *preventive action* of lightning-conductors, is justly regarded as the *most important* function of such rods; although, under certain extraordinary circumstances, they may be forced to carry disruptive discharges. Under any circumstances, however, it is obvious that *pointed* conductors must *enlarge* the protected area as compared with *blunt* conductors.

It is very difficult, if not impossible, to estimate in a precise manner how this *power of points* would *modify* and *distort* the *equipotential surfaces* in the intervening electric field. The problem is evidently one of great complexity. The following circumstances must obviously influence, to a greater or less extent, the *magnitude* and *direction* of the resultant electromotive force, which determines the path of discharge, *connective* or *disruptive*, viz.: (1) *Distance* of thunder-cloud from the point of the conductor; (2) variable *dielectric properties* of the intervening air; (3) *size* of the cloud; (4) the variable *tension* of its electric charge, especially under the neutralising action of the pointed rod; and (5) the *velocity* with which the thunder-cloud approaches the point of the conductor. The last consideration is very important, and at the same time most difficult to formulate; for the *connective neutralisation* is a *gradual* process requiring *time*. It is evident that a heavily-charged thunder-cloud *rapidly* driven towards the point of the conductor might give rise to a *disruptive* spark, while, if *slowly* approaching the same, it would have been *silently neutralised*, and the stroke averted. In fact the strength and direction of the resultant force is influenced by so many variable conditions that it would tax the resources of a powerful calculus to indicate a formula which would satisfy, even approximately, the demands of practice in the construction of lightning-conductors.

Nevertheless, it is quite certain that Mr. Preece's rule, which makes the radius of the protected circular area equal to the *height* of the rod for *blunt* conductors, is perfectly *safe* for *pointed* rods; for there can be no question as to the fact that the "*power of points*" *enlarges* the protected area.

The late Prof. Henry frequently witnessed the efficacy of connective discharges from the point of the lightning conductor attached to the high tower of the Smithsonian Institution. During violent thunder-storms at night, at every flash of lightning he observed that "a jet of light, at least five or six feet in length, issued from the point of the rod with a hissing noise."

It is proper to add that while the circumstances influencing *disruptive* discharges of electricity have been experimentally investigated by a number of physicists, the laws of *connective* discharges from points do not seem to have received attention from any experimenter. Thus I have not been able to find a satisfactory answer to the following elementary inquiry, viz.—Under given conditions, at what *distance* will a pointed conductor connected with the earth *begin* to neutralise the electricity of an insulated conductor by the connective discharge of the opposite kind of electricity from the point?

In short, the whole subject of the "*power of points*," although one of the best-established and most conspicuous phenomena in electricity, is sadly in need of experimental investigation. This class of electrical phenomena is pretty much in the same condition in which Franklin left it more than a century ago.

Berkeley, California, January 1

JOHN LE CONTE

[Mr. Preece has shown by considering the area between the conductor and the charged cloud as an electric field mapped out in equipotential surfaces and lines of force, that "a lightning-rod protects a conic space whose height is the length of the rod, whose base is a circle having its radius equal to the height of the rod, and whose side is the quadrant of a circle whose radius is equal to the height of the rod."—*Phil. Mag.*, December, 1880.—ED.]

Localisation of Sound

My friend the Rev. H. J. Marston, Second Master of the School for Blind Sons of Gentlemen at Worcester, has communicated to me some very singular instances of the power of localising sound possessed by blind boys.

One of the games in which his pupils most delight is that of *bowls*. A bell is rung over the nine-pins just as the player is ready to throw the bowl, when, totally blind as he is, he delivers it with considerable accuracy of aim. Mr. Marston vouches for the fact that it is no uncommon feat for a boy to strike down a single pin at a distance of forty feet three times in succession.

It is significant that this game cannot be played by the blind boys in windy weather. And yet the allowance for windage on a heavy bowl can be no very large quantity.

The boys also play football with great zeal and considerable skill. Bells are rung at the goals throughout the game, and the ball contains two little bells. With these guides the boys manage both to follow the ball and to direct it to the goals.

Clifton College, February 15

H. B. JUPP

Migration of the Wagtail

THE inclosed extract from the New York *Evening Post*, a newspaper of high standing for accuracy and intelligence, contains statements which are not, I think, generally known in regard to the migration of the water-wagtail, and your insertion of the same may be the means of drawing from other correspondents some evidence in confirmation or disproof. Though riding is not quite unknown among animals other than men, yet such purposeful riding as is here described is, to say the least, very extraordinary.

E. W. CLAYPOLE

Antioch College, Yellow Springs, Ohio, Dec. 12, 1880

The Singular Methods of Travel the Wagtail adopts to Cross the Mediterranean Sea.—In the autumn of 1878 I spent several weeks on the Island of Crete. On several occasions the papas—village priest—a friendly Greek with whom I spent the greater part of my time—frequently directed my attention to the twittering and singing of small birds which he distinctly heard when a flock of sand-cranes passed by on their southward journey. I told my friend that I could not see any small birds, and suggested that the noise came from the wings of the large ones. This he denied, saying, "No, no! I know it is the chirping of small birds. They are on the backs of the cranes. I have seen them frequently fly up and alight again, and are always with them when they stop to rest and feed." I was still sceptical, for with the aid of a field-glass I failed to discover the "small birds" spoken of. I inquired of several others, and found the existence of these little feathered companions to be a matter of general belief among both old and young. I suggested that possibly the small birds might go out from the shore a short distance and come in with the cranes. "No, no," was the general answer, "they come over from Europe with them." I certainly heard the chirping and twittering of birds upon several different occasions, both inland and out upon the sea. But in spite of the positive statements of the natives I could not believe their theory until convinced one day while fishing about fifteen miles from the shore, when a flock of cranes passed quite near the yacht. The fishermen, hearing the "small birds," drew my attention to their chirping. Presently one cried out "There's one," but I failed to catch sight of it. Whereupon one of them discharged his flint-lock. Three small birds rose up from the flock and soon disappeared among the cranes.

I subsequently inquired of several scientific men, among whom were two ornithologists, as to the probability of such a state of affairs. They all agreed that it could not be, and I, too, was forced to cling to my original judgment, and let the matter go. Recently however while reading the *Gartenlaube* my attention was attracted to an article bearing directly upon the subject. The writer, Adolf Ebeling, tells the same story, and adds the statements of some ornithologists of distinction, which makes the whole matter so striking and interesting that I quote the paragraph from his book:—

"Shortly after my arrival in Cairo I greeted various old German friends among the birds that I observed in the palm-garden of our hotel. First, naturally, was the sparrow, the impudent proletariat—I had almost said social democrat, because the whole world to-day has that bad word in the mouth. He appeared to me to be more shameless than ever in the land of the Pharaohs, for he flew without embarrassment on the breakfast table, and picked off the crumbs and bits from every unwatched place. But the mark of honour we paid to the wagtails, and in truth chiefly because we did not then know that the wagtails were birds of passage. We had thought that they passed the winter in Southern Europe, or at farthest as many of them do, in Sicily and the Grecian Islands. That they came to Africa, and especially to Nubia and Abyssinia, was then unknown to us. This appeared to us singularly strange, nay, almost incredible, particularly on account of the peculiar flight of the wagtail, which it is well known always darts intermittingly through the air in longer or shorter curves, and apparently, every few moments, interrupts

its flight to sit again and 'wag its tail.' But there was the fact, and could not be denied. Everywhere in the gardens of Cairo you could see them under the palms that border the banks of the Nile; on the great avenues that lead to the pyramids; nay, even on the pyramids themselves in the middle of the desert. And there it was that I first heard of this singular phenomenon.

"One evening we were sitting at the foot of the pyramid of Cheops, sipping our cup of fragrant Mocha and in jolly conversation, rolling up clouds of blue smoke from our Korani cigarettes. We were waiting for the sinking of the sun to make our return to Cairo. The deep silence of the surrounding desert possessed something uncommonly solemn, only now and then disturbed by the cry of the hoarse fishhawks far above us. Still higher the pelicans were grandly circling. Their flight, though heavy when seen from afar, possesses a majesty in the distance attained by no other bird. Right before us several wagtails were hopping around and 'tilting.' They were quite tame, and flew restlessly hither and thither. On this occasion I remarked, 'I could not quite understand how these birds could make the long passage of the Mediterranean.' Sheik Ibrahim heard this from our interpreter. The old Bedouin turned to me with a mixture of French and Arabic as follows, which the interpreter aided us to fully comprehend:—

"'Do you not know, Hadretch (noble sir), that these small birds are borne over the sea by the larger ones?'

"I laughed, as did our friends; for at first we thought we had misunderstood him; but no: the old man continued quite naturally:—

"'Every child among us knows that. These little birds are much too weak to make the long sea journey with their own strength. This they know very well, and therefore wait for the storks and cranes and other large birds, and settle themselves upon their backs. In this way they allow themselves to be borne over the sea. The large birds submit to it willingly; for they like their little guests, who by their merry twitterings help to kill the time on the long voyage.'

"It appeared incredible to us. We called to a pair of brown Bedouin boys, pointed out the wagtails to them, and inquired:—

"'Do you know whence come these small birds?'

"'Certainly,' they answered. 'The Abu Saad (the stork) carried them over the sea.'

"At supper, in the Hôtel du Nil, I related the curious story to all present, but naturally found only unbelieving ears.

"The only one who did not laugh was the Privy Councillor Heuglin, the famous African traveller, and, excepting Brehm, the most celebrated ornithologist of our time for the birds of Africa. I turned to him after the meal, and inquired of his faith. The good royal councillor smiled in his caustic way, and with a merry twinkle remarked: 'Let the others laugh: they know nothing about it. I do not laugh, for the thing is known to me. I should have recently made mention of it in my work if I had had any strong personal proof to justify it. We must be much more careful in such things than a mere story-teller or novel-writer; we must have a proof for everything. I consider the case probable, but as yet cannot give any warrant for it.'

"My discovery, if I may so call it, I had kept to myself, even after Heuglin had thus expressed himself, and would even now maintain silence on the subject had I not recently discovered a new authority for it."

I read lately in the second edition of Petermann's great book of travels the following:—

"Prof. Roth of Munich related to me in Jerusalem that the well-known Swedish traveller, Hedenborg, made the following interesting observation on the Island of Rhodes, where he stopped. In the autumn tide, when the storks come in flocks over the sea to Rhodes, he often heard the songs of birds without being able to discover them. Once he followed a flock of storks, and as they lighted he saw small birds fly up from their backs, which in this manner had been borne over the sea. The distance prevented him from observing to which species of singing birds they belonged."

Thus wrote the famous geographer Petermann. Prof. Roth and Hedenborg and Heuglin are entirely reliable authors. This was a matter of great curiosity to me, and after I found others had made similar observations and expressed them in print, I thought they would be of no less curiosity and interest on this side of the Atlantic, and equally deserving of public notice. I hope that connoisseurs, amateurs, and experts may be excited by this to extend their observation in this line also. The instinct of animals is still, in spite of all our observations and experience,